

consistent with airborne astronomy applications) (fig. 1). The multiple gain is achieved by having several integrating capacitors in the feedback loop that can be enabled in eight possible combinations.

These devices have been designed, developed, and characterized; their first application is intended to be for the far-IR detector array of the airborne infrared echelle spectrometer (AIRES), a facility instrument for the Stratospheric Observatory for Infrared Astronomy (SOFIA). To date, several of these devices have been tested; they showed adequate performance, although better performing devices are expected when the processing is refined and better controlled. The typical read-noise at the highest gain setting and with correlated double sampling is about 250 electrons. Further tests are under way, and this readout will be integrated with a 1 x 24 prototype Ge:Sb array in the near future.

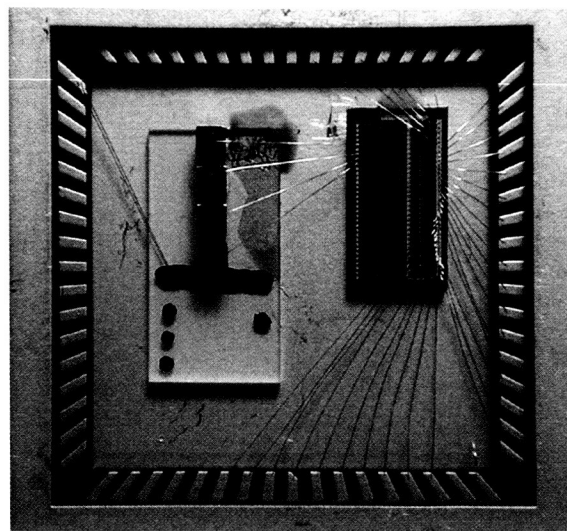


Fig. 1. A prototype 1 x 32 SB-190 multiplexer bonded to 4 Ge:Ga far-infrared detectors.

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Guide Star Telescope Detector Assembly for Gravity Probe-B

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Because of extensive experience in low-temperature detector and readout technology and the challenging technical and programmatic requirements, Ames is continuing to lead the development and manufacture of the guide star telescope detectors of the Gravity Probe-B (GP-B) Project. GP-B is a Stanford University/Lockheed Martin/Marshall Space Flight Center Physical Science mission. The scientific purpose of GP-B is to test Einstein's theory of General Relativity, which has been only partially verified and is one of the least tested of all physical theories.

The GP-B fine motion guide star tracking system uses a 5.6-inch-aperture, all-fused quartz telescope attached to a quartz block assembly containing the relativistic effect-sensing gyroscopes. The guide star telescope rotates about its central axis, thereby providing

a constant pointed reference direction to a star that is fixed on the celestial sphere. This setup provides the critical inertial reference frame for the spacecraft. The satellite that contains this assembly, scheduled to be launched late in 2002, will be in a polar orbit about the Earth. The precession rate of the sensed gyroscope directional output from the inertial reference frame is a possible indication of a general relativistic deviation from that expected by Newtonian gravitational theory. A precession rate is expected to occur at a scale of a few arcseconds per year (arcsec/year), and it is expected to be measured with an accuracy of about 0.2 milliarcsec/year. For comparison, the apparent angular diameters of the few nearest stars, visible to all but the largest telescopes as points of light, are less than 10 milliarcseconds.

Progress in FY00 has been significant. The GP-B telescope subsystem, with which Ames personnel has significant involvement, has been demonstrated to function in ground tests with sensitivity levels commensurate with the design, and adequate for all mission requirements. The detector module assembly is shown in figure 1. The real-time pointing accuracy of the x-axis and y-axis detector pairs achieve sensitivities limited by noise levels of 8 and 10 milliarcseconds/ $\sqrt{\text{hertz}}$, respectively. The mission requirement is 10 milliarcseconds/ $\sqrt{\text{hertz}}$, which is set by the theoretical shot-noise-limited photon arrival rate. Hence, during the 3-minute period of the spacecraft roll, the pointing accuracy is limited to about 80 microarcseconds of angle on the sky. Also being investigated are the possible interfering effects that may degrade the performance during the mission, whether they arise from astronomical, atmospheric, terrestrial, or spacecraft factors.

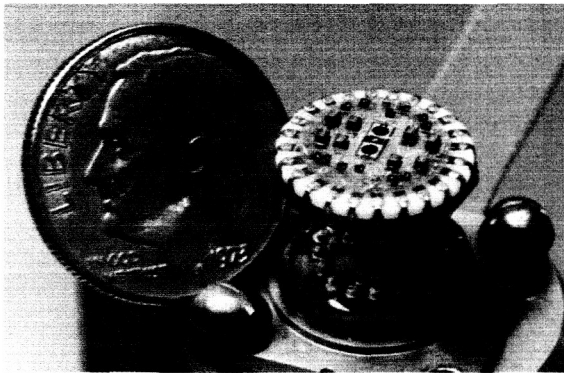


Fig. 1. Detector module assembly for GP-B.

A picture of the quartz telescope with the attached light detectors is shown in figure 2. The telescope is standing on its base plate. Light enters from above, is reflected into the upper structure, the knife edge divider assembly, where the beam is divided equally between a total of eight photodiodes. The equality of this division determines the error signal that is sent back to the control circuits that readjust the spacecraft orientation. Four detectors are



Fig. 2. GP-B quartz telescope assembly.

needed for complete control; the other four are identical, but redundant. The detectors are at the top of the figure. Signals are conveyed via flexible printed circuits to connectors that interface the detectors thermally and electrically to a low-thermal-conductivity cable bundle (not shown) that is part of the science instrument assembly.

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